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Seth Armitage [a]
University of Edinburgh, UK

Janusz Brzeszczyński [b, *]
Heriot-Watt University, UK

Anna Serdyuk [c]
University of Edinburgh, UK

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[a] University of Edinburgh Business School, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom; e-mail: seth.armitage@ed.ac.uk

[b] Department of Accountancy, Economics and Finance, Heriot-Watt University, Edinburgh, EH14 4AS, United Kingdom, e-mail: j.brzeszczynski@hw.ac.uk

[c] University of Edinburgh Business School, 29 Buccleuch Place, Edinburgh, EH8 9JS, United Kingdom; e-mail: anna.serdyuk@yahoo.com

* Corresponding author.

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ABSTRACT

We provide the first in-depth study of trading on the Ukrainian stock exchange, using trade-by-trade data. Though Ukraine has some large listed companies, the market is quite illiquid. We study the efficiency of five liquidity measures in the market. The proportion of no-trading days is the most reliable of the five, while turnover, which is widely used in the literature, is a poor measure. On trading cost, trades in all size categories are executed within the quoted spread, as in other dealership markets, with medium-sized trades being the cheapest. The cost of sales is higher than the cost of purchases in all market conditions.

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1. Introduction

The liquidity and costs of trading on a stock market are crucial features for investors and for companies that are listed or contemplating a listing. In many emerging markets, difficulties in trading can make institutional investment almost impossible except in a small number of the most liquid stocks. Lack of professional investment in a given company in turn implies a lack of analysts who will follow the company, and reduced incentive and pressure for the company to provide information to the market. Lower liquidity is associated with higher transaction costs of raising share capital (Butler et al. 2005), and with a higher expected return on equity, or cost of equity, gross of trading costs (for example, Hearn et al. 2010). Both these factors make equity capital more expensive than it would be were the company's shares more liquid. Bond markets also tend to be illiquid in emerging markets, with little or no secondary trading. If the practical opportunities for professional investment are limited in a given economy, this impedes the growth of investing institutions, which in turn reduces access to savings products on the part of the population, and reduces the productivity of their savings. For these and other reasons, a healthy financial sector is generally recognised as beneficial for economic growth, by mobilising savings more effectively and improving access to capital for companies (for example, Demirgüç-Kunt and Levine 1996). Liquidity is a key index or symptom of the health of a given stock market and the associated investment industry. It is also a causal factor, in that more active trading will tend to lead to lower trading costs, greater production of information, and more interest in the relevant stocks from potential investors.

It is therefore important to be aware of the liquidity and costs of a given market, and to know how best to measure these two features. For emerging markets there is very limited academic evidence to date. Our paper makes two contributions. First, it offers the first in-depth study of the liquidity and costs of trading on the Ukrainian stock market. Previous papers do not include Ukraine in their samples, and so little is known about it in the academic literature; the

microstructure data have barely been studied (the only exception is Ryzkhov 2007, who studies the components of the bid-ask spread). Yet Ukraine is a large country with considerable potential for growth; its stock market has been open for nearly fifteen years, and there are more than 300 companies listed. We were able to obtain data that includes trade-by-trade prices and amounts, together with intraday and closing best bid and ask quotes of dealers.

Second, the paper compares several measures of liquidity and trading costs. Since liquidity and trading costs are important aspects of a market to understand and measure, it is worthwhile to establish which measures an investor or policymaker should concentrate on. The assumption that available liquidity measures are able to capture the liquidity of stocks is not often tested for emerging markets, because of data limitations. As a consequence, there is little consensus on which measures are better. A few studies investigate the efficacy of liquidity measures for the U.S. stock market (Goyenko et al. 2009; Hasbrouck 2009; Lesmond et al. 1999), and for a number of emerging stock markets (Bekaert et al. 2007; Lesmond 2005), but, to our knowledge, none do so for Ukraine. It is worthwhile to study liquidity measures in emerging markets because the commonly used measures were designed for developed markets and little is known about their applicability to emerging markets.

We examine stock-market trading in Ukraine for the period 2005-06. These were fairly normal years in terms of market conditions, and they include sub-periods with both rising and falling markets, which is an advantage. We test the efficacy of five measures of stock liquidity by comparing them across stocks, using the quoted bid-ask spread as the benchmark measure, as in Lesmond (2005). The proportion of no-trading days, the proportion of zero-return days, stock volatility, and Amihud's (2002) measure show high correlations with the quoted spread, and are therefore found to be satisfactory liquidity measures for Ukraine. The measure most highly correlated with the spread is the proportion of no-trading days. Our fifth measure, turnover, is ubiquitous in the literature, but it has a much lower correlation with the quoted spread than the

other measures and is clearly the least satisfactory of the five. Our finding regarding turnover confirms that of Lesmond (2005) for other emerging markets. The finding for the proportion of zero-return days adds to the evidence in Bekaert et al. (2007) that this is a good measure for emerging markets; it is less good for developed markets. When measured by the proportion of zero-return days, Ukraine is found to be less liquid than Korea and Taiwan, though more liquid than Chile and Colombia.

The second part of our study examines several measures of the cost of trading, including the quoted and effective bid-ask spread. In line with previous research, the effective spread is smaller than the quoted spread, which provides evidence that traders are able to negotiate price improvement from brokers in relation to quoted stock prices. We believe that the reason for price improvement is the desire of brokers to sustain long-term relationships with their clients, who are other brokers in our case, in order to secure future deals with them, as argued by Bernhardt et al. (2005) for the UK.

For the 15 most liquid Ukrainian stocks, the average effective bid-ask spread is 4.3 per cent. It is highest for small trades, 4.5 per cent, lower for medium-sized trades, 3.7 per cent, and starts growing again for large trades, 4.1 per cent. The finding that the cost of trading for small trade sizes is higher than for larger trades is documented in other literature for dealership markets (Hansch et al. 1999; Huang and Stoll 1996; Reiss and Werner 1996). This finding is consistent with the reasoning in Bernhardt et al. (2005). Small trades are not viewed as valuable for brokers and therefore price improvement cannot be negotiated for them and they have to be executed near to the quotes. Larger trades are more valuable, and in order to keep the relationship with clients in the long-term, price improvement is offered for these trades. But for very large trades, the loss of profit on the trade implies a material reduction in the incentive to offer price improvement. In addition, it is likely to be costly for a dealer to find counterparties for very large amounts.

A further finding is that the average cost of trading for an institutional sale is higher than that for an institutional purchase, whether the market is rising, falling, or neutral. We did not expect this result. The findings in other research show that institutional purchases are more expensive than sales in a rising market, while the sales are more expensive in a falling market (Bikker et al. 2007; Chan and Lakonishok 1993; Chiyachantana et al. 2004; Keim and Madhavan 1998). However, the *relative* cost of trading in the Ukrainian stock market during a falling and a rising market compared to the cost of trading in a neutral market does follow the pattern predicted in Chiyachantana et al. (2004): in a falling market the cost of sales rises by more than the cost of purchases in relation to their values in the neutral market, while in a rising market the opposite is true.

Our study of the determinants of the cost of trading shows that the quoted and effective bid-ask spreads depend on stock liquidity, measured by the number of no-trading days per year and the average number of trades per day,[1] with higher liquidity stocks having narrower bid-ask spreads, as expected. Also, the quoted and effective spreads depend on the riskiness of the stock, measured by return volatility and stock price, with more risky stocks having wider bid-ask spreads. These findings are in line with those for other exchanges, in particular, NYSE and Nasdaq (Stoll 2000), London Stock Exchange (Naik and Yadav 2003), and Euronext Paris (Gajewski and Gresse 2007). Firm size, measured as market capitalization, is found not to be an important determinant of the spread; this is probably the result of the very low free float for many large companies on the Ukrainian stock market.

Our data indicate that nearly all Ukrainian stocks are illiquid when compared with large stocks in developed markets. For example, the proportion of days with no trading in the stock is typically between about 20% and 50% even for the most liquid stocks (Table 2). Our findings add to the evidence that low liquidity is associated with higher cost of trading. An important step to

improve liquidity, and reduce cost of trading, would be for the proportions of shares in the free floats of Ukrainian companies to be increased.

The paper proceeds as follows. Section 2 provides an overview of the Ukrainian stock market, and Section 3 reviews the most relevant literature on liquidity measures and trading costs. Section 4 discusses our data and its limitations, and describes the various measures we study. The results are presented in Section 5. Section 6 concludes.

2. The stock market and listed companies in Ukraine

The Ukrainian stock market emerged in the mid-1990s, after the beginning of privatisation of the state-planned economy. It has been developing quickly. By the end of the 2000s it had become one of the largest stock markets in Eastern Europe by market capitalization. Standard & Poor's classifies it as a frontier market, ie one of a subgroup of emerging markets and are investable but have lower market capitalization or liquidity than the more developed emerging markets. The other European frontier markets are Bulgaria, Croatia, Estonia, Latvia, Lithuania, Romania, Slovak Republic, and Slovenia.

In 2005-06 there were eight registered stock exchanges in Ukraine, of which PFTS (First Stock Trading System) was the largest, accounting for 74 per cent of the organized equity market. The remaining seven exchanges had low activity and performed limited operations, acting mainly as facilitators in the State Property Fund privatization process (USAID 2006). The market capitalization of PFTS increased from $5bn (10 per cent of GDP) in 2003 to $112 bn (78 per cent of GDP) in 2007 (PFTS Annual Report 2008). The number of listed companies has varied between 191 and 335 during 2003-07.

PFTS has a dealership market structure with multiple brokers posting their quotes on an electronic trading system, PFTS NEXT. The trading system is viewed as highly transparent and effective with respect to technology.[2] Trades are executed between brokers on-line through a

private network, often after negotiation via telephone. Information posted by the brokers, such as the name of the stock, and bid and ask prices and quantities, is visible on the screen to all authorized subscribers to the trading system. Brokers can act as agents, executing an order of an investor, or as principals, trading for their own accounts. Normally no separate commission is charged. When a broker acts as an agent, he suggests a price to the investor which includes the broker's remuneration. In March 2009 a new stock exchange, the Ukrainian Exchange (UX), was opened. It introduced to the market the long-awaited order-driven trading technology and quickly won a large portion of equity trading volume.

The main shareholders in Ukrainian equity are domestic companies, which account for 83 per cent of the total equity holdings (SCSSM 2007). Domestic individuals account for 11 per cent of the total holdings. Foreign investors only account for 7 per cent. Large blocks of equity are mainly held by Ukrainian business groups, ie financial-industrial conglomerates, or groups of vertically integrated companies.

Legislation concerning the Ukrainian securities markets complies well with international practice in some ways (EBRD 2008). However, there are problems with enforcement, and disclosure and transparency requirements are low; for example, prospectuses often omit price-sensitive information, and there is relatively weak protection of minority shareholders' rights (EBRD 2007). Standard & Poor's and Financial Initiatives Agency performed a study of the informational transparency and ownership concentration of Ukrainian public companies (S&P/FIA 2008). The average transparency index for the market as a whole is very low, 24 per cent, though Ukrainian companies that undertake an IPO in the international stock markets have considerably higher transparency. The study also finds a high level of ownership concentration. Only five companies out of the 36 studied have dispersed stock ownership, and these five represent only 4 per cent of the market capitalization. Thirty-one companies have at least one shareholder who owns more than 25 per cent of the company, and 25 have controlling shareholder with more than

50 per cent. The large owner is a Ukrainian business group in 22 of the companies, and the government in the other nine.

In summary, there are very few listed companies with widely held shares. All of the larger listed companies are controlled by large groups. Standards of disclosure and protection of minority shareholders are not good even compared with other emerging markets.

3. Previous research

3.1 Liquidity measures

Four types of liquidity measure are found in the literature: (i) measures related to the cost of trading, (ii) measures related to trading activity, (iii) compound liquidity measures, and (iv) alternative liquidity measures. The main measures related to the cost of trading are quoted bid-ask spread, effective bid-ask spread, and price impact. Jain (2003) estimates the daily quoted bid-ask spread for 51 stock exchanges over a four-month period and finds that the quoted spread is a good indicator of underlying liquidity, and Lesmond (2005) applies the quoted spread as a benchmark for studying the efficacy of other liquidity measures. The effective bid-ask spread is taken as one of the benchmark liquidity measures in Goyenko et al. (2009). A problem with both spread measures is that the data are not available for some markets; also, it can be more convenient to infer liquidity from other data. Therefore there is a need to study the efficacy of different liquidity measures.

Among the measures related to trading activity, turnover is the one most commonly applied. It is normally computed as the ratio of the average number of shares traded per day to the number of shares outstanding. The benefit of the measure is that it captures trading volume for a stock and is simple to construct, but its drawback is that it fails to account for the cost per trade, which varies considerably across stocks.

Several compound liquidity measures have been suggested in the recent literature. The most widely used is probably that of Amihud (2002); it is the daily absolute return divided by the

daily value of trading. This ratio closely follows the Kyle (1985) price-impact definition of liquidity, or the response of price to order flow. An advantage of Amihud's measure is that it can be calculated for days when there is no price change, but it cannot be calculated if a zero-volume day occurs.

Alternative liquidity measures are often substitutes for established measures and are applied in markets with poor data availability or poor quality of data. The proportion of zero-return days in a period exploits the effect transaction costs may have on daily returns. The maintained hypothesis is that the marginal, informed trader will trade only if the value of information exceeds the marginal costs of trading (Lesmond et al. 1999). If trading costs are sizable, zero-return days occur more frequently because new information must accumulate longer, on average, before informed trades can affect price. The cost of trading is a threshold that must be exceeded before the return on a security will reflect new information. A security with high cost of trading will have less frequent price movements and more zero returns than a security with low cost of trading. But the proportion of zero-return days has a serious limitation, in that it does not measure no-trading days but zero-return days, and zero return can occur on days with non-zero trading. The proportion of no-trading days is seen as a better measure by Bekaert et al. (2007) and Lesmond et al. (1999).

Volatility of return is not directly related to the definition of liquidity but is found to be highly correlated with liquidity measures and is therefore viewed as a liquidity proxy (Domowitz et al. 2001; Lesmond 2005). Less liquid stocks usually have a higher volatility of return.

A few recent papers study the efficacy of liquidity measures. Lesmond (2005) examines turnover, the proportion of zero-return days, Amihud's measure, Roll's measure, and the LOT measure.[3] His dataset contains 31 emerging markets for the period of 1987-2000 but covers only about 12 per cent of listed companies in each market. Lesmond concludes that the LOT measure, Amihud's measure, Roll's measure, and the proportion of zero-return days have power in

measuring liquidity in emerging equity markets. His results cast doubt on the use of turnover in assessing either cross-country or within-country liquidity. Bekaert et al. (2007) conclude that the proportion of zero-return days appears to be picking up a component of liquidity and transaction costs that turnover does not, and they apply zero-return days to study the influence of liquidity on expected asset returns in emerging markets. They are unable to use bid-ask spread for many markets due to lack of data.

A recent study by Goyenko et al. (2009) analyses the performance of a wide selection of low-frequency liquidity measures using U.S. data. Low-frequency measures are easier to compute than high-frequency measures (such as the effective spread), though the latter are usually presumed to have higher precision. The study tests six low-frequency measures that are spread proxies, such as zero-return days, and four that are price-impact proxies, such as Amihud's measure. The authors conclude that both monthly and annual low-frequency measures usefully capture high-frequency measures of transactions costs, so the effort of calculating high-frequency measures is not worth the cost. Which measure a researcher should use depends on what exactly the researcher wants to measure.

Not all liquidity measures respond to trading pressure in the same way. As Chordia et al. (2001) show, volume-based and cost-of-trading-based measures are found to behave differently in turbulent times in the market. Even though trading activity and trading costs are often assumed (and shown) to be related, they capture different aspects of the market and do not always behave similarly. For example, while trading-activity variables increase both in rising and falling markets, bid-ask spreads respond asymmetrically by increasing significantly in falling markets and decreasing marginally in rising markets. Therefore it is worth bearing in mind what market conditions prevailed during a given sample period, when comparing liquidity measures.

3.2 Cost of trading

Researchers usually distinguish between explicit and implicit costs of trading. Explicit costs include broker commissions and taxes. Implicit costs include the bid-ask spread, price-impact costs, delay costs, and opportunity costs. In Ukraine there are no taxes on trading and brokers' commissions are built in into quoted prices, so we are concerned solely with implicit costs. Our discussion is restricted to cost measures and evidence that are most related to emerging markets, and to our own investigation.

The quoted bid-ask spread is a benchmark measure of both liquidity and the cost of trading. But it is not an accurate measure of the trading cost. First, it tends to overstate the true spread because trades are often executed inside the quoted spread. Second, both the bid and ask prices have a systematic tendency to rise (fall) following a purchase (sale), so the round-trip trading costs are less than the quoted spread suggests. A better measure in principle is the effective spread, which is based on the prices at which trades are actually executed. These are the two measures that we calculate.

An important question is the relationship between the cost of trading and trade size. Several papers report that large orders receive worse prices on the NYSE, including Bernhardt and Hughson (2002), Huang and Stoll (1996), Keim and Madhavan (1996) and Lee (1993). The standard explanations are that large trades impose large inventory exposure on the market maker, and that block traders could have trouble finding liquidity, because liquidity-suppliers suspect that block traders have superior information (Barclay and Warner 1993; Hansch et al. 1999; Harris 2003; Seppi 1990).

However, the opposite relationship between cost and trade size is documented for dealership markets like the London Stock Exchange (LSE) and Nasdaq. For the LSE, Reiss and Werner (1996) find that larger trades receive better prices, except for unusually large orders. Hansch et al. (1999) find that in the LSE price improvement in relation to the quoted spread is

smallest for small trades, larger for medium-sized trades and largest for large trades. For Nasdaq, Huang and Stoll (1996) report an average effective half-spread of 19.9 cents per share for small trades and 13.5 cents for large trades.

The asymmetric-information theory fails to explain the relationship between the cost of trading and trade size in dealership markets. The inference is that there are reasons for price improvement for larger trades that outweigh the information considerations. Bernhardt et. al (2005) emphasise competition for an order. In a dealer market, a broker chooses a dealer with whom to trade and then negotiates the final price with him. The broker will switch dealers in the future if, for a given order size, he does not obtain sufficient price improvement. Their results show that the price improvement offered i) rises with the value of the relationship between a broker-dealer pair, and ii) falls with the current order size, holding the relationship fixed. A similar explanation of price improvement in a dealership market is offered by Rhodes-Kropf (2005).

Empirical research documents an asymmetry in the cost of trading between buyer- and seller-initiated trades, with many studies showing that purchases are more expensive than sales. Most authors attribute the asymmetry to a higher portion of informed trading in institutional purchases than in sales. Keim and Madhavan (1996) and others argue that purchases are more likely to be based on private information because they create new long positions. Chan and Lakonishok (1993) argue that an institutional investor typically has limited alternatives to sell an asset since the number of stocks in his portfolio is limited, and therefore the decision to sell does not necessarily convey negative information. In contrast, the choice of buying a specific stock, out of all the stocks traded on the market, is more likely to be motivated by favourable firm-specific information.

However, Saar (2001) develops a theoretical model that relates the cost of institutional trading to the underlying economic environment, and demonstrates that a stock's history of price run-ups and run-downs influences the asymmetry. The model predicts that purchases have greater

price impact than sales following a long period of price run-ups. The opposite is true after a series of price run-downs. The idea of Saar (2001) is further developed and tested by Chiyachantana et al. (2004). Their empirical results confirm the hypothesis that in a rising (falling) market the price-impact cost of trading for institutional purchases (sales) is greater than that for sales (purchases). Investing institutions pay for consuming liquidity when they buy in rising markets and sell in falling markets. When trading against the run of the market, institutions effectively provide liquidity and, therefore, face lower cost of trading. A study by Bikker et al. (2007) of the cost of trading for a Dutch pension fund during a bear market, finds that sales are more expensive than purchases, which is consistent with the predictions in Chiyachantana et al. (2004). The earlier studies that document a higher cost of trading for purchases than for sales all use the data from periods when the market condition was bullish.

Another strand of research investigates factors that determine the bid-ask spread across stocks. Stoll (2000) hypothesizes that the spread depends on factors related to a stock's liquidity and risk. Using U.S. data, he runs a cross-sectional regression of the quoted spread on five determinants, namely trading volume, number of trades per day, free float, return variance, and stock price. Every coefficient has its expected sign and is significantly different from zero, and the R^2 exceeds 0.60. Referring to previous literature, Stoll (2000, p. 1481) concludes that the relationship has changed little over time and adds that 'the empirical relation is very strong… Few empirical relations in finance are this strong'. Naik and Yadav (2003) report similar results for the London Stock Exchange stocks.

However, the results are not entirely confirmed by Gajewski and Gresse (2007), using data from Euronext Paris and the London Stock Exchange. They add the imbalance between purchase and sale orders to the five variables tested, and find that trading volume, return variance, and order imbalance have their expected signs and are significantly different from zero, but free float, stock price, and number of trades per day are found to be insignificant.

We have reviewed research concerning the relationship between cost of trade and trade size; whether the trade is a buy or a sell; the market condition at the time of the trade; and stock-specific factors that determine the trade cost. We study all these questions using Ukrainian data, for the first time.

4. Data and calculation of the measures

4.1. Data

Our dataset was obtained directly from the stock exchange PFTS. It contains: (i) intraday best bid and ask quotes and quantities up to which the broker is willing to trade the relevant stock; (ii) best closing bid and ask quotes and quantities; (iii) information about each trade, ie the PFTS code to identify the stock, trade price, trade quantity, date, and time of trade. Trading in PFTS is done in the Ukrainian currency, hryvnya, and all the estimations in this paper are done in Ukrainian currency too. For the reader's convenience, all the monetary values are stated in U.S. dollars using an exchange rate of 5.09 UAH/USD, the average official exchange rate during 2005-06.[4]

Trading activity in the market was very low until 2005. The total volume of trading on PFTS in 2004 was only $207m, compared to $644m in 2005 and $1,168m in 2006. The number of actively traded companies was very low too until 2005. When we started our research, we were able to obtain data from PFTS for the period 1 January 2005 to 30 November 2006.

Excluded data. Many of the listed stocks in PFTS are small and have very low trading frequency. Therefore, we include only stocks that have an average market capitalization of at least $10m and at least ten trades per year during 2005-06. This leaves us with a sample of 56 stocks. The smallest has an average market capitalization of $10m, the largest $3,261m. The total capitalization of the 56 stocks represents 73 per cent of the capitalization of all listed stocks. Due to the prevalence of institutional trading in the Ukrainian stock market, the average value per trade on

PFTS is quite large, $46,798; the minimum average value across the stocks is $8,648, and the maximum is $1,017,927. It should be emphasised that the excluded stocks are extremely illiquid, with only a few trades *per year*. Several of the measures of liquidity and cost of trading cannot meaningfully be calculated for such stocks. Even the quoted bid-ask spread is highly suspect. We note, however, that the proportion of days with no trading, which performs well as a liquidity measure for the 56 shares in the sample, can sensibly be calculated for less liquid shares.

The trading session in PFTS lasts from 11 a.m. till 5 p.m. From 9 a.m. till 11 a.m. certain trades executed during the two previous days are reported. Our study of liquidity requires data on all executed trades, so trades reported before 11 a.m. are retained in the dataset for this part of our analysis. Inclusion of these trades allows us to estimate volume-related liquidity measures more accurately (turnover, Amihud's measure, and the proportion of no-trading days), without influencing estimates of the quoted bid-ask spread, the proportion of zero-return days, and the volatility of return, as these latter measures are estimated from the closing bid-ask spread data only. But our study of the cost of trading requires knowledge of the time of execution of a trade, and so trades reported before 11 a.m. are excluded from the dataset when we study the cost of trading. Exclusion of these trades reduces the sample by 34 per cent.

Estimation of liquidity over the full period of 2005-06 results in very high standard errors for some of our liquidity measures. Therefore, for the assessment of liquidity, we limit the sample period to the first six months of 2006. In crisis times, the volume of trading and the cost of trading can change significantly (Yeyati et al. 2007), but the Ukrainian stock market did not experience any shocks or crises. There was gradual growth during January-April (the PFTS Index increased by 35 per cent) and gradual decline during May-June (the Index fell by 20 per cent).

Our study of the cost of trading requires high-frequency transaction data. For this reason, we limit the sample for cost of trading to the 15 most liquid stocks (the cost of trading study is done for the whole sample period, 2005-06). Descriptive statistics for these stocks are presented in

Table 1. They represent 38 per cent of the total PFTS market capitalization and 33 per cent of the trading volume. The market capitalization among the chosen 15 stocks ranges from $60m for DTRZ to $3,261m for UTEL; the number of trades for the stocks ranges from 262 for PGOK to 851 for UTEL. The average value per trade is $43,866, with a range between $16,191 for MMKI and $90,918 for UNAF.

Table 1 around here

Outliers. The dataset is not corrected for price outliers when examining liquidity measures, because actual stock prices are not used to estimate any of the measures. Rather, the closing bid-ask quote is used to estimate midpoint prices and stock returns. All the quotes are checked for cases in which the ask price is greater than the bid price, but no such cases are identified. When examining the cost of trading, we exclude outliers according to the following rule: for each stock we exclude all trades with an absolute return, measured against price of the previous trade, that lies beyond two standard deviations from the mean absolute return per trade for the stock. Application of this rule leads to the exclusion of 5.4 per cent of the trades.

Limitations. The PFTS data have some limitations. First, they do not reflect all the trades executed for PFTS-listed securities. Ukrainian legislation does not require that all trades executed with an exchange-listed security are reported to the stock exchange. As a result, some trades of PFTS-listed securities can be performed over the counter with no reporting to PFTS. There is official data on the total volume of over-the-counter trades executed for all stocks (both listed and not listed), but no separate data on the volume of these trades for exchange-listed stocks. Based on our knowledge of the Ukrainian stock market, we believe that the majority of trades of stocks in the free float are executed via PFTS brokers, while large blocks of stocks held by business groups are bought or sold off-exchange, through negotiation between the interested parties.[5]

Second, some of the trades executed by PFTS brokers for PFTS-listed stocks are not reported to PFTS. It was not obligatory until May 2008 for trades between a PFTS broker and a

non-member of PFTS (third-party trades) to be reported to PFTS. Brokers could report these trades voluntarily at a specially allotted time, before the opening of the trading session at 11 a.m. during the next two trading days after the trade. Third-party trades which stay unreported are lost for our study. However, we expect that the percentage of lost trades is not high, because brokers have an incentive to report third-party trades. Higher trading volume increases the position of a broker in the rating of PFTS brokers, which is published by PFTS monthly and is based on the volume traded per broker. This is the only rating of brokers issued in Ukraine and a higher position in the rating is viewed as an important constituent of a broker's reputation. Also, the delay of up to two days is likely to make brokers less concerned about the potential price impact of news of a trade. Finally, many third-party trades are actually reported; they represent 44 per cent of total PFTS trading by value.

In order to assess whether the trades we can include are representative of all trades, we compare the properties of third-party trades reported before 11 a.m. with the properties of trades performed during the trading session. We provide a summary only of these results, to save space. In terms of trade size, third-party sales have a very similar structure to trading-session sales. Small, medium, and large trades account for similar proportions by number and dollar volume in third-party sales as in trading-session sales (our size categories are explained in Section 4.3). However, the structure of third-party purchases differs from the structure of trading-session purchases. The proportion of large third-party purchases is 25 per cent, much more than the 11 per cent of trading-session purchases which are large, and the average volume of a large third-party purchase is $0.41m compared with $0.29m for a large trading-session purchase. These findings suggest that our cost-of-trade estimates for trading-session sales can be extrapolated to all the sales on PFTS, but since large buys are under-represented in our sample, we may not measure accurately the cost of large buys.

4.2. Liquidity measures

The liquidity measures that we estimate are the quoted bid-ask spread, turnover, Amihud's measure, proportion of zero daily returns, proportion of no-trading days, and volatility of return.

i) Quoted bid-ask spread:

$$QS_{i,T} = \frac{A_{i,T} - B_{i,T}}{(A_{i,T} + B_{i,T})/2} \quad (1)$$

where $A_{i,T}$ is the best quoted ask price for stock i at the close of day T, and $B_{i,T}$ is the best closing bid price.

ii) Turnover (defined as in Lesmond 2005):

$$Turnover_i = (1/D_H)\sum_{T=1}^{H} \frac{Volume_{i,T}}{Shares_i} \quad (2)$$

where D_H is the number of trading days in period H, $Volume_{i,T}$ is the number of shares traded in stock i on day T, and $Shares_i$ is the number of shares in issue at the beginning of period H.

iii) Amihud's measure:

$$Amihud'sMeasure_i = (1/D_H)\sum_{t=1}^{H} \frac{|R_{i,T}|}{MQ_{i,T} * Volume_{i,T}} \quad (3)$$

where $MQ_{i,T} = (A_{i,T} + B_{i,T})/2$ is the midpoint of the quotes at the close of day T, and $R_{i,T} = (MQ_{i,T} - MQ_{i,T-1})/MQ_{i,T-1}$ is the return for day T. The value of (3) is multiplied by 10^6 as in Amihud (2002) and elsewhere. Amihud's measure relates price impact (percentage change in price) to the volume of stock traded. A lower value of Amihud's measure implies higher liquidity. If zero volume occurs on a given day, then Amihud's measure cannot be computed for that day, and it is excluded from the calculations.

iv) Proportion of zero-return days: the ratio of the number of days with a return of zero to the total number of trading days over a given period.

v) Proportion of no-trading days: the ratio of the number of days with no trading to the total number of trading days over a given period. A lower proportion of zero-return days, or of no-trading days, indicates higher liquidity.

vi) Volatility of return: the standard deviation of the daily return over a given period. Lower volatility of a stock indicates higher liquidity.

4.3. Cost of trading

Our analysis of the cost of trading includes estimation of the quoted bid-ask spread, as defined in (1), the effective half-spread, and price improvement. The effective half-spreads for a sale and for a purchase are, respectively,

$$ES_{i,t}^{sale} = \frac{MQ_{i,t} - P_{i,t}}{MQ_{i,t}} \quad (4)$$

$$ES_{i,t}^{purchase} = \frac{P_{i,t} - MQ_{i,t}}{MQ_{i,t}} \quad (5)$$

where $P_{i,t}$ is the price of a trade for stock i at time t, and $MQ_{i,t}$ is the most recent midquote price prevailing before the trade. The effective half-spread can be expressed in relation to the quoted spread in terms of price improvement, defined as:

$$PI_{i,t}^{sale} = \frac{P_{i,t} - B_{i,t}}{B_{i,t}} \quad (6)$$

$$PI_{i,t}^{purchase} = \frac{A_{i,t} - P_{i,t}}{A_{i,t}} \quad (7)$$

The trade direction is not identified in the PFTS data, but we need the direction to estimate the effective half-spread. Two approaches are used in the literature to infer the direction of a trade: (i) comparison of the trade price to the price of the preceding trade, a technique known as the tick test, or (ii) comparison of the trade price to the most recent midquote price, known as the Lee and

Ready (1991) method. The latter is more accurate (Ellis et al. 2000), and as we have the requisite data, this is the method we use:

$$Trade_{i,t} \equiv SELL \qquad if\ P_{i,t} < MQ_{i,t}$$

$$Trade_{i,t} \equiv BUY \qquad if\ P_{i,t} > MQ_{i,t}$$

where $MQ_{i,t}$ is the midquote at time just before time t. If a trade took place at the midquote, we cannot identify whether it was a purchase or a sale and we therefore exclude it from the sample. 5.9 per cent of observations (after removing outliers) are excluded for this reason.

The laborious process of matching trades with the preceding quotes in the 2005-06 data was carefully done for Ryzhkov's (2007) study.[6] The trades and quotes are on the same day for all but 0.2 per cent of trades, and the average time between the trade and the closest preceding quote is one hour and seven minutes. Fifty-nine per cent of the trades are matched with a quote with a difference in time of 30 minutes or less.

We measure trade size in relation to a normal market size (NMS) defined as the median trade size (number of shares traded) for the relevant stock. Trades executed in 2005 (2006) are related to the median trade size for each stock during 2005 (2006). The average value of the relative trade size, as just defined, varies from three to five times NMS for the majority of the stocks. Therefore we set the following rule for division of the trades into size groups: small trades are less than two NMS, medium-sized trades are between two and six times NMS, and large trades are six times NMS or more. The same categories are used in Hansch et al. (1999). Our rule classifies 70 per cent of trades as small, 19 per cent as medium-sized, and 11 per cent as large. In terms of value, small trades account for 14 per cent of the total, medium-sized for 17 per cent and large for 69 per cent. To estimate the cost of trading in different market conditions, the 2005-06 period is divided into three sub-periods according to whether the market was rising, falling, or neutral. There is no generally accepted definition of rising and falling markets in the literature (Lunde and Timmermann 2004). We define a rising (falling) market as a price increase (decline) of at least 0.15

per cent per day on average over at least 25 consecutive trading days, which is a modification of the rule suggested by the Vanguard Group.[7] Based on this definition, during 2005-06 there was a rising market for 290 days, a falling market for 220 days, and a neutral market for 127 days.

5. Results

First we investigate the efficacy of various liquidity measures for Ukrainian stocks, and compare the liquidity of the Ukrainian market with that of other emerging markets. Then we turn to the cost of trading.

5.1.1. Efficacy of liquidity measures

We use the bid-ask spread as the benchmark for studying the efficacy of other measures, as in Goyenko et al. (2009) and Lesmond (2005). We choose the quoted spread as the benchmark rather than the effective spread because the data on closing quoted spreads are available daily for a wide range of Ukrainian stocks. To estimate effective spreads reliably, frequent data on the prices of executed trades are needed, which are not available for many stocks due to low trading frequency.

Table 2 around here

The estimated liquidity measures for each stock in the sample are presented in Table 2.[8] According to our benchmark measure, quoted bid-ask spread, the ten most liquid companies are mainly large companies, with a market capitalization of between \$86m and \$3,216m. These companies have quoted spreads between 3.3 per cent and 8.0 per cent. The ten least liquid companies by quoted spread are mostly small, with a market capitalization between \$15m and \$66m, though they include two large companies: USCB (\$1,294m) and ALMK (\$451m). The bid-ask spread for the ten least liquid companies ranges from 50.7 per cent to 140.4 per cent.

The results by turnover (Table 2, columns 5-6) differ considerably from those by quoted spread. Some companies in the top ten by quoted spread are in the bottom ten by turnover. For example, UTEL and AZST have quoted spreads of 3.3 per cent and 7.5 per cent respectively but average daily turnover in the six-month sample period of only 0.004 per cent. At the same time SVGZ, with a very high spread of 74.6 per cent, appears in the top ten by turnover. These results are possibly due to different levels of free float for the companies. The free floats of UTEL and AZST are 7.14 per cent and 2.75 per cent respectively, whereas the free float of SVGZ is 12.8 per cent.[9]

Amihud's measure tends to assign liquidity in line with the quoted spread (columns 7-8). For example, UTEL, UNAF, and LTPL have ranks 1, 2, and 10 respectively by quoted spread and 3, 2, and 7 respectively by Amihud's measure. SFER, ALMK, and HMBZ have ranks 53, 56, and 51 respectively by quoted bid-ask spread and 54, 52, and 51 by Amihud's measure.

Zero-return days are fairly prevalent among Ukrainian stocks. The proportion varies from 10.3 per cent to 100 per cent (columns 9-10). HMON had just eight trades in the first half of 2006, with no change in quotes (ie 100 per cent zero returns). The proportion of zero returns tends to be low for companies in the top-ten liquidity group by quoted spread, and high for companies in the bottom ten by quoted spread. The only two exceptions are SHKD and YAMZ which are in the bottom ten by spread, with spreads of 50.7 per cent and 64.0 per cent respectively, but in the top ten by zero-return days, with proportions of 10.3 per cent and 19 per cent.

We also observe a close relation between quoted spread and proportion of no-trading days. The majority of the ten most liquid companies by spread appear in the top ten by proportion of no-trading days, which ranges for them from 10.3 per cent to 21.6 per cent (columns 11-12). The only exception is DNON with 70.1 per cent of no-trading days. All the bottom-ten stocks by quoted spread appear in the bottom ten by proportion of no-trading days, which varies for them between 79.5 per cent and 99.2 per cent.

The volatility of return varies from 0 per cent to 26.8 per cent (columns 13-14). For the top-ten companies by quoted spread, volatility ranges between 0.9 per cent and 2.5 per cent. For the bottom ten, volatility ranges between 4.2 per cent and 26.8 per cent. But there is a problem with this measure if there is no price change for a stock over time. It is very probable that no change in price is an indication of low liquidity in the stock. But volatility of return will give the opposite indication. It will show 0 per cent volatility for the stock which implies high liquidity. A case in point is HMON, with quoted spread of 100 per cent, proportion of no-trading days of 94 per cent, and no price change (0 per cent volatility).

Next, we discuss the results of three types of correlations; time-series correlations, cross-sectional correlations, and rank correlations. Daily time-series correlations are computed for the quoted spread and turnover, and for the quoted spread and Amihud's measure. It is expected that if turnover for a stock rises on day *t*, the bid-ask spread will narrow for the stock on this day, and that if price impact per unit of volume rises, the spread will widen. If a liquidity measure does not change from one day to the next, the day of no change is excluded from the computation, since no variation in one of the two variables can lead to a biased estimate of the correlation coefficient.

To calculate cross-sectional and rank correlations, we take averages of the daily values for each stock of the quoted spread, turnover, and Amihud's measure. The other measures have a single value per stock per year. All the estimates of the rank correlations are expected to have a positive sign since rank 1 represents the highest liquidity for any liquidity measure, and rank 56 the lowest liquidity. We omit the time-series correlations for each stock, to save space. The cross-sectional correlations are presented in Table 3 and the rank correlations in Table 4.

Tables 3 and 4 around here

Quoted spread and turnover. The majority of the time-series correlation coefficients are negative, as expected, but insignificantly different from zero. The cross-sectional correlation between the quoted spread and turnover is -0.16 and is not significantly different from zero. The

rank correlation is 0.17 and is not significant either. These results suggest that turnover is a poor measure of liquidity in Ukraine, which is in line with the findings in Bekaert et al. (2007) and Lesmond (2005) for other emerging markets. The latter finds that turnover is negatively and significantly correlated with bid-ask spread in only nine of the 23 emerging markets studied. Lesmond (2005, p. 423) concludes that, 'the most telling finding is the lack of correlation between turnover and the bid-ask spread… These results cast doubt on a wide range of studies employing turnover as a principal liquidity proxy.'

Quoted spread and Amihud's measure. The time-series correlations for each stock show a high level of interrelation between these two measures. For 18 out of 52 companies the correlations are significant and quite high, from 0.24 to 1.00. Cross-sectional correlation of the two measures is high at 0.44, and significant at the 1 per cent level. The rank correlation is 0.51 and is also significant at the 1 per cent level. These results suggest that Amihud's measure is applicable in Ukraine; Lesmond (2005) draws the same conclusion for other emerging markets. His study finds positive and significant correlations that vary from 0.19 for Taiwan to 0.64 for Argentina. He notes that 'the results for Amihud's measure perhaps are surprising given that the bid-ask spread is not often associated with price impact costs' (p. 428). Goyenko et al. (2009) find that Amihud's measure is highly correlated with the effective spread for U.S. stocks. So Amihud's measure tends to work well in both emerging and developed markets.

Quoted spread and proportion of zero-return days and no-trading days. The cross-sectional correlations are 0.50 and 0.62 respectively, both significant at the 1 per cent level. The rank correlations are 0.60 and 0.81 respectively. Therefore both measures perform well, though the higher correlation coefficients for the proportion of no-trading days suggest better applicability of this measure. Our results for the proportion of zero-return days are in line with the findings in Bekaert et al. (2007) for nine emerging markets, though the results in Goyenko et al. (2009) show that the proportion of no-trading days is not effective for the U.S. market.

The proportions of zero returns and no-trading days show higher correlations with the quoted spread than does Amihud's measure, suggesting that the former two measures perform better in Ukraine. This result is possibly due to the absence of dependence of the two proportions on turnover, which, as we have seen, is not a good proxy for liquidity.

Quoted spread and volatility of return. The cross-sectional correlation is 0.51 and the rank correlation 0.80, both significant at the 1 per cent level. These results indicate that volatility is a good proxy for liquidity.

To summarize, four of the five measures examined show high and significant correlation with the quoted bid-ask spread. We therefore conclude that they are all satisfactory measures of liquidity for the Ukrainian stock market. The proportion of no-trading days shows the highest correlation with the quoted spread and is therefore considered to be the most satisfactory measure. It will also be a good measure even for very illiquid stocks, for which the bid-ask spread might be suspect as there are so few trades. Turnover shows a very low association with the quoted spread and we find it to be an ineffective measure. The reason for this could be that turnover is measured in relation to the number of shares in issue (see eq. 2). Large, relatively liquid stocks could nevertheless have a relatively low figure for turnover because they have a large number of shares in issue. On the basis of our findings and the previous evidence, we suggest that the proportion of no-trading days and the quoted spread are good candidates as measures of liquidity for emerging markets. They are as straightforward to calculate and as reliable as any other measures.

5.1.2. Comparison with other emerging markets

The only detailed studies of liquidity in emerging stock markets are Bekaert et al. (2007) and Lesmond (2005); neither includes Ukraine. Our dataset covers a larger proportion of Ukrainian listed stocks, 56 out of 262 listed, than the proportions in the country datasets used by Lesmond (2005). On average, 12 per cent of the number of listed stocks for each country are included, and

they are the most liquid stocks.[10] To make the liquidity estimates for Ukraine comparable, we recalculate them including only 12 per cent (30) of the listed stocks. Our recalculated estimates together with the liquidity estimates for seven emerging markets from Lesmond are presented in Table 5. Note that our data for Ukraine are from 2006, whereas Lesmond's data are from the 1990s.

Table 5 around here

By volume-related measures of liquidity, i.e. turnover and Amihud's measure, Ukraine is the least liquid among the eight emerging markets considered. The reason for this is probably the peculiar feature of the Ukrainian stock market – the very low free float. Because of the low free float, turnover (the ratio of shares traded to shares outstanding) in Ukraine is extremely low. Also, an increase in daily volume traded causes considerable price impact in Ukraine, which is reflected in the high value of Amihud's measure compared with other countries.

According to the quoted spread, Ukraine comes behind all the emerging markets concerned except Russia. By the proportion of zero returns, Ukraine ranks higher, fourth of the eight markets. A similar ranking can be inferred from the results in Bekaert et al (2007). The smaller proportion of zero-return days for Ukraine than for certain other emerging markets suggests that, even though the free float in Ukraine is very low, the circulation of the free float in Ukraine is more active than in, say, Chile and Colombia.

5.2. Cost of trading

5.2.1. Effective spread and size of trade

Tables 6 and 7 around here

Table 6 reports the average quoted and effective bid-ask spreads for the 15 most liquid Ukrainian stocks. The effective spread for every stock is substantially smaller than the quoted spread, and this is true of unreported estimates for the remaining 41 stocks in the sample. The finding that the effective spread is within the quoted spread is in line with the results for the US

and UK markets (Hansch et al. 1999; Huang and Stoll 1997; Lee 1993; Naik and Yadav 2003; Stoll 2000).

The average effective spread in relation to trade size is presented in Table 7 (the row 'Total' for each of the trade sizes). The mean effective half-spread is found by taking the average of the mean effective half-spreads across all the stocks in the sample, and the mean effective half-spread for a given stock is the average of the effective half-spreads for each trade in the stock during the sample period. Small trades are the most expensive to execute; they have the highest effective spread of 4.54 per cent, whereas medium-sized trades are the cheapest, with a spread of 3.70 per cent. The spread for large trades is 4.09 per cent. The finding that small trades are the most expensive to execute is in line with other studies of dealership markets.

As the majority of investors in the Ukrainian stock market are institutions, there are not many really small trades. The average value of what we classify as a small trade in PFTS is $19,300. Small trades in the Ukrainian stock market are comparable by value to medium-sized trades in developed markets. As medium-sized trades in Ukraine can be compared to large trades in London, our results are in line with the findings in Reiss and Werner (1996), who document that large trades (but not unusually large) are the cheapest to execute on the London Stock Exchange. Large trades in the Ukrainian stock market are more expensive than medium-sized trades. Bernhardt et al. (2005) find that while price improvement rises with the value of the relationship with a given broker on the LSE, beyond a certain size of order, larger orders receive increasingly poor prices.

5.2.2. Difference in the cost of trading for sales and purchases

On average, sales cost 2.46 per cent in terms of effective half-spread, while purchases cost 1.87 per cent (Table 7). The cost of trading for sales is found to be higher than that for purchases for every market condition (rising, falling, and neutral). This result is unexpected as most other

studies find that purchases are more expensive than sales in a rising market, while sales are more expensive in a falling market (Bikker et al. 2007; Chan and Lakonishok 1993 and 1995; Chiyachantana et al. 2004; Keim and Madhavan 1997).

Despite the fact that the cost of trading for sales is higher in every market condition, the *relative* cost of trading – the cost of trading during rising and falling markets relative to the cost during a neutral market – is in line with the pattern predicted and documented in Chiyachantana et al. (2004). In a neutral market, sales are executed at an effective spread of 2.18 per cent and purchases at 1.71 per cent. During a rising market the cost of sales grows by 0.20 percentage points, or 9 per cent of the neutral-market cost of sale, to 2.20 per cent, and the cost of purchases grows more, by 23 per cent of the neutral market cost. During a falling market, the cost of sales grows by 37 per cent of the neutral-market cost, and the cost of purchases grows less, 30 per cent. So, in relation to a neutral market, purchases during a rising market become more expensive than sales, and sales during a falling market become more expensive than purchases.

Why the cost of sales is higher than that of purchases in any market condition is not entirely clear. One possible explanation is that investors tend to be more patient on the buy side than on the sell side, and therefore sales are more expensive because they have to pay for immediacy of order execution.

5.2.3. Determinants of the spread

We study the determinants of the cost of trading measured as the quoted bid-ask spread and then measured as the effective spread. The quoted spread allows us to include all 56 stocks in our dataset. It is reported daily, whether or not any trades were executed in the relevant stock. The effective bid-ask spread is a more accurate measure of the cost of trading, but a reliable estimate of the effective spread can be found only for liquid stocks. We measure the variables for the 15 most liquid stocks on a monthly basis, as in Gajewski and Gresse (2007) and Stoll (2000).

Stoll (2000) hypothesizes that the bid-ask spread depends on factors related to a stock's liquidity and risk. Liquidity-related factors considered in his study are daily dollar trading volume, number of trades per day, and firm size; the risk of a stock is measured by stock-return variance and stock price (stocks with high return variance and low price are considered be riskier). Following Stoll (2000), we run the following regression of the quoted bid-ask spread on the stock's trading characteristics:

$$S_{it} = a_0 + a_1 \log DDV_{it} + a_2 \sigma_{it}^2 + a_3 \log Mcap_{it} + a_4 \log MQ_{it} + a_5 \log N_{it} + e_{it} \qquad (8)$$

where S_{it} is the quoted spread for stock i during period t, DDV_{it} is daily dollar volume of trading, σ_{it}^2 is return variance, $Mcap_{it}$ is market capitalization, MQ_{it} is midquote price, N_{it} is number of trades per day, and e_{it} is the error term. Daily dollar volume, price, and number of trades per day are calculated as averages of the daily values over the relevant year, 2005 or 2006. Market capitalization is taken at the beginning of each year. Return variance is calculated based on daily stock returns over the year.

Table 8 around here

OLS estimation results for equation (8) are reported in Table 8. Return variance, price, and the number of trades per day have the expected sign and are significant at the 5 per cent level or better. Market capitalization and daily dollar volume also have the expected sign but are insignificantly different from zero. The ease of finding a counterparty for a trade is expected to be greater for larger firms, but the free float is low for some large Ukrainian firms. We have seen already that volume is not a good proxy for liquidity. In view of these results, we substitute the number of no-trading days for daily dollar volume, and we exclude market capitalization. The new specification of the spread-determinants regression is therefore:

$$S_{it} = a_0 + a_1 \log NNTD_{it} + a_2 \sigma_{it}^2 + a_3 \log MQ_{it} + a_4 \log N_{it} + e_{it} \qquad (9)$$

where $NNTD_{it}$ is the number of no-trading days for stock i in year t.

All the explanatory variables have the expected signs and are significant at the 10 per cent level or better (Table 8). The quoted spread is higher for stocks with lower liquidity (stocks with a higher number of no-trading days and lower number of trades per day) and for stocks with higher risk (stocks with higher return volatility and lower price). The results are in line with the findings in other literature (Gajewski and Gresse 2007; Naik and Yadav 2003; Stoll 2000).

Equation (9) takes into account only those determinants of the bid-ask spread which are related to the order-processing and inventory-holding costs. In order to take into account differences in informational efficiency, we add an index of the transparency of Ukrainian stocks, which is based on 105 criteria (S&P/FIA 2008). However, the information index is not significant.

Table 8 also reports the results for the 15 most liquid stocks, with effective half-spread as the dependant variable, using monthly data. The effective spread has intraday frequency, so the average over each day is calculated first, and then the average of the daily values is taken over a given month. The variance of the daily returns is also computed monthly. The explanatory variables in the new regression are the same as in equation (9). The results are similar to the results for the quoted spread, except that the number of trades per day now lacks significance. The proportion of no-trading days, return variance, and price have the expected signs and are significant at the 5 per cent level or better. We note that our results provide further evidence that higher liquidity is associated with lower cost of trading.

6. Conclusion

The paper offers the first detailed study of liquidity and trading costs in the Ukrainian stock market. It adds to the rather limited evidence on the microstructure of emerging markets. We are able to study a variety of measures because our dataset includes both trade-by-trade prices and bid-ask quotes from dealers. We discuss several key features of the Ukrainian market: the presence of a large controlling interest in most listed companies, the very low free floats, the dominance of

institutional trading, and the low liquidity and high costs of trading in all but a handful of stocks. Our results mostly serve to confirm the findings of previous papers that examine the microstructure of emerging markets.

We find that the proportion of zero-return days, the proportion of no-trading days, stock volatility and Amihud's measure are all satisfactory measures of liquidity, at least judging by their correlation with the quoted spread and with each other. Turnover performs poorly, as it does for several other emerging markets, and is not recommended as a liquidity measure for an illiquid market. The proportion of no-trading days is one of the best measures. It does not perform well for liquid markets such as the NYSE, but it is a straightforward and reliable measure for less liquid markets.

On the cost of trading, we find that trades of all sizes receive a price improvement over the quoted price. The cheapest to execute are trades that are medium-sized in the context of Ukraine; these are large by the standards of the London Stock Exchange, for example. The reason for the prevalence of large trades in Ukraine is the scarcity of retail investors. We find that sales are more expensive than purchases, which is a surprise, and that this holds for all market conditions (falling, rising, and neutral market). The reason for the greater cost of sales is not obvious.

The cost of trade (quoted or effective spread) for a given stock is related to proxies for the stock's risk and liquidity. However, neither the volume of trading nor the market capitalization of the company have explanatory power, unlike for the US and UK markets. Overall, our findings show that liquidity is low or almost non-existent for all but the largest Ukrainian stocks, and that low liquidity is associated with a higher cost of trading. An important reason for low liquidity, though not the only one, is likely to be the small free floats for most Ukrainian shares. If ways can be found of increasing free floats, this would be likely to promote the development of the stock exchange and an investment industry in Ukraine. A natural extension of the research would be to

estimate the components of the effective spreads, i.e. the proportions represented by order-processing, inventory and asymmetric-information costs.

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Table 1. Descriptive statistics for the 15 most liquid Ukrainian stocks, January 2005 - November 2006.

	Company Name	PFTS code	Industry	Mcap, ($m)	Mean price ($)	Number of trades	Volume traded ($m)	Average volume per trade ($m)
1	Azovstal	AZST	Metallurgy	1,709.23	0.54	485	10.99	22,632
2	Raiffeisen Bank Aval	BAVL	Finance	1,184.68	0.08	538	47.24	87,760
3	Dniproenergo	DNEN	Power Engineering	292.73	74.48	236	16.99	72,009
4	Dnipropetrovsk Pipe	DTRZ	Tube Rolling	60.12	56.92	320	11.01	34,423
5	Luganskteplovoz	LTPL	Mechanical Engineering	79.57	0.36	530	18.07	34,094
6	Maruipol Heavy Machinery	MZVM	Mechanical Engineering	143.03	9.3	428	15.35	35,865
7	Interpipe Nyzhnyodniprovsky Tube Rolling Plant	NITR	Tube Rolling	438.11	8.15	389	19.86	51,071
8	Poltavsky Iron Ore	PGOK	Mining & Coke	1,155.21	10	262	22.19	84,589
9	Sumy Frunze	SMASH	Mechanical Engineering	249.51	3.51	403	14.23	35,337
10	Stirol	STIR	Chemical	534.38	19.74	273	10.2	37,328
11	Ukrnafta	UNAF	Petrochemical	2,455.80	45.11	624	56.73	90,918
12	Ukrsotsbank	USCB	Finance	1,406.68	0.38	347	20.04	57,750
13	Ukrtelecom	UTEL	Telecommunications	3,261.30	0.17	851	17.41	20,467
14	Zakhidenergo	ZAEN	Power Engineering	371.32	29.09	363	14.41	39,737
15	Zaporizhstal	ZPST	Metallurgy	135.95	1.16	585	15.26	26,103
	Total			**13,477.60**		**6,634**	**309.99**	**46,728**

Notes: The companies are listed alphabetically by PFTS Code. The market capitalization (Mcap) is calculated using the mean stock price, which is calculated across the trades for each stock.

Table 2. Estimates of five liquidity measures for 56 Ukrainian stocks

N	PFTS Code	Liquidity measure											
		Quoted bid-ask spread	Rank	Turnover	Rank	Amihud (*10^6)	Rank	Proportion of zero-return days	Rank	Proportion of no-trading days	Rank	Volatility of Return	Rank
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**UTEL**	3.32%	1	0.00%	48	0.055	3	10.34%	1	9.40%	1	1.34%	5
2	**UNAF**	4.24%	2	0.02%	30	0.031	2	16.38%	4	17.95%	2	0.92%	1
3	**ZAEN**	5.16%	3	0.03%	20	0.136	15	21.55%	9	44.44%	14	1.43%	6
4	**NITR**	5.24%	4	0.02%	26	0.133	13	27.59%	19	33.33%	6	1.83%	20
5	**MMKI**	5.96%	5	0.00%	51	0.18	21	12.93%	3	43.59%	12	1.59%	10
6	**BAVL**	6.66%	6	0.03%	16	0.605	44	26.72%	18	35.04%	8	1.82%	18
7	**AZST**	7.46%	7	0.00%	49	0.311	31	24.14%	14	28.21%	4	1.96%	22
8	**DNON**	7.76%	8	0.01%	43	0.102	12	50.00%	39	70.09%	35	1.54%	9
9	**CEEN**	7.94%	9	0.03%	17	0.243	28	25.00%	15	38.46%	10	1.25%	3
10	**LTPL**	8.02%	10	0.17%	4	0.08	7	25.86%	16	22.22%	3	2.46%	29
11	**DNSS**	8.04%	11	0.03%	18	0.169	19	25.86%	17	46.15%	15	1.75%	17
12	**MZVM**	8.22%	12	0.03%	15	0.073	4	32.76%	24	36.75%	9	1.10%	2
13	**PGOK**	8.22%	13	0.01%	33	0.201	22	36.21%	27	43.59%	13	1.44%	7
14	**STIR**	8.22%	14	0.01%	35	0.556	42	31.03%	22	52.14%	20	2.37%	28
15	**KSTL**	8.48%	15	0.00%	52	0.206	24	43.10%	33	65.81%	29	1.63%	11
16	**DTRZ**	8.52%	16	0.18%	3	0.1	11	24.14%	13	35.04%	7	2.18%	25
17	**ZACO**	9.36%	17	0.02%	27	0.089	8	43.97%	34	58.97%	23	1.47%	8
18	**SMASH**	9.40%	18	0.02%	23	0.284	30	22.41%	10	40.17%	11	2.32%	27
19	**KIEN**	9.48%	19	0.06%	9	0.099	10	43.10%	32	60.68%	24	1.25%	4

20	**AVDK**	10.50%	20	0.01%	47	0.156	18	29.31%	21	48.72%	17	1.69%	13
21	**YASK**	10.62%	21	0.13%	5	0.281	29	32.76%	25	58.12%	22	2.81%	34
22	**DNEN**	10.78%	22	0.05%	12	0.154	17	19.83%	7	52.14%	19	1.70%	14
23	**NVTR**	10.80%	23	0.03%	19	0.211	25	54.31%	41	65.81%	32	1.82%	19
24	**MSICH**	10.82%	24	0.01%	39	0.51	41	27.59%	20	47.86%	16	2.73%	33
25	**ZPST**	11.06%	25	0.08%	8	0.144	16	23.28%	11	29.06%	5	2.13%	24
26	**DOEN**	11.22%	26	0.01%	40	0.314	32	20.69%	8	65.81%	28	1.74%	16
27	**DKOK**	12.36%	27	0.04%	13	0.485	40	39.66%	29	55.56%	21	2.02%	23
28	**GLNG**	12.82%	28	0.05%	11	0.467	38	84.48%	53	88.89%	47	6.27%	48
29	**DOMZ**	13.52%	29	0.01%	36	0.47	39	33.62%	26	64.10%	25	2.70%	32
30	**RODB**	15.40%	30	0.32%	2	0.074	5	24.14%	12	94.02%	52	1.71%	15
31	**DGRM**	16.26%	31	0.10%	7	1.03	47	18.97%	5	70.09%	34	4.04%	41
32	**ZALK**	18.56%	32	0.01%	41	0.328	33	44.83%	36	64.10%	27	2.28%	26
33	**ZFER**	19.50%	33	0.01%	44	0.663	46	54.31%	42	73.50%	37	3.76%	38
34	**MEGA**	20.72%	34	0.40%	1	0.135	14	41.38%	31	89.74%	49	6.56%	49
35	**FORM**	22.50%	35	0.00%	50	0.33	34	87.07%	55	96.58%	55	1.94%	21
36	**ZAON**	24.36%	36	0.01%	37	0.03	1	75.86%	51	88.89%	45	2.51%	31
37	**TATM**	24.46%	37	0.02%	29	0.356	37	31.90%	23	75.21%	38	3.04%	37
38	**PGZK**	25.92%	38	0.04%	14	0.205	23	38.79%	28	51.28%	18	4.04%	40
39	**KRAZ**	27.18%	39	0.01%	45	4.2	53	70.69%	50	82.91%	42	13.00%	54
40	**DRMZ**	29.00%	40	0.01%	34	1.16	49	47.41%	38	65.81%	31	4.67%	44
41	**DNAZ**	29.44%	41	0.12%	6	0.569	43	55.17%	43	71.79%	36	3.99%	39
42	**ZHEN**	30.34%	42	0.02%	28	0.079	6	77.59%	52	88.89%	46	2.47%	30
43	**KREN**	36.72%	43	0.03%	22	0.093	9	62.07%	45	78.63%	39	4.67%	45
44	**NFER**	37.08%	44	0.00%	53	0.237	27	87.07%	54	82.91%	43	1.63%	12
45	**HANZ**	37.46%	45	0.03%	21	0.222	26	43.97%	35	64.10%	26	2.90%	35
46	**AZOT**	44.58%	46	0.01%	42	0.336	35	62.93%	46	92.31%	50	2.97%	36
47	**SHKD**	50.68%	47	0.02%	25	1.46	50	10.34%	2	89.74%	48	4.64%	43

48 **DMPZ**	54.58%	48	0.01%	38	1.05	48	56.03%	44	80.34%	41	6.27%	47
49 **USCB**	56.34%	49	0.01%	46	0.353	36	46.55%	37	65.81%	30	4.17%	42
50 **YAMZ**	64.02%	50	0.00%	54	-	-	18.97%	6	99.15%	56	8.44%	51
51 **HMBZ**	68.84%	51	0.02%	31	1.76	51	39.66%	30	79.49%	40	11.01%	53
52 **SVGZ**	74.64%	52	0.06%	10	0.632	45	53.45%	40	67.52%	33	26.79%	55
53 **SFER**	76.74%	53	0.00%	55	9.44	54	68.10%	48	86.32%	44	7.87%	50
54 **DMZK**	86.68%	54	0.02%	32	0.169	20	69.83%	49	93.16%	51	8.91%	52
55 **HMON**	100.00%	55	0.02%	24	-	-	100.00%	56	94.02%	54	0.00%	-
56 **ALMK**	140.38%	56	0.00%	56	2.05	52	64.66%	47	94.02%	53	6.22%	46
Average	**14.76%**		**0.02%**		**0.28**		**31.27%**		**44.88%**		**2.03%**	

Notes: For each liquidity measure, the table reports the rank of the relevant stock. Rank 1 is the highest liquidity, rank 56 the lowest. The calculations are explained in Section 4.2. The sample period is the first half of 2006.

Table 3. Cross-sectional correlations between the liquidity measures

	Quoted bid-ask spread	Turnover	Amihud (× 10^6)	Proportion of zero returns	Proportion of no-trading days	Return volatility
Quoted bid-ask spread	**1** (-)					
Turnover	**-0.1624** (-0.232)	**1** (-)				
Amihud (*1,000,000)	**0.4428***** (-0.001)	**-0.1495** (0.281)	**1** (-)			
Proportion of zero returns	**0.4981***** (0.000)	**-0.1678** (0.216)	**0.2545*** (0.063)	**1** (-)		
Proportion of no-trading days	**0.6185***** (0.000)	**0.0407** (0.764)	**0.2899**** (0.033)	**0.6665***** (0.000)	**1** (-)	
Return volatility	**0.5081***** (0.000)	**0.0268** (0.845)	**0.3562***** (0.008)	**0.2197** (0.104)	**0.3412***** (0.010)	**1** (-)

Notes: The table shows cross-sectional correlations computed from the averages for each measure for each stock during the first half of 2006. The p-value of the t-statistics is reported in parentheses. Number of observations: 56.

Table 4. Rank correlations between liquidity measures

	Turnover	Amihud *1,000,000	Proportion of zero returns	Proportion of no-trading days	Return Volatility
Quoted bid-ask spread	0.1653 (0.223)	0.5112*** (0.000)	0.5958*** (0.000)	0.8090*** (0.000)	0.8028*** (0.000)

Notes: The estimates are found by correlating the ranks of stocks by quoted bid-ask spread with the ranks by alternative liquidity measures. The p-value is in parentheses. Number of observations: 56.

Table 5. Liquidity estimates for a selection of countries from Lesmond (2005) and the adjusted liquidity estimates for Ukraine.

Country	Quoted bid-ask spread, %	Rank by quoted bid-ask spread	Turnover	Rank by Turnover	Amihud (*10^6)	Rank by Amihud	Prop-n of zero daily returns	Rank by prop-n of zero daily returns
Chile	-	-	0.28%	5	0.15%	4	42.27%	7
Colombia	4.52%	5	0.06%	7	0.00%	1	50.94%	8
Czech Republic	8.15%	6	1.25%	2	0.43%	5	32.28%	5
Korea	1.95%	2	1.58%	1	0.01%	2	15.33%	2
Poland	3.13%	3	0.33%	4	1.90%	6	19.37%	3
Russia	47.22%	7	0.22%	6	4.88%	7	41.55%	6
Taiwan	1.09%	1	1.21%	3	0.04%	3	11.57%	1
Ukraine	8.98%	4	0.02%	8	18.60%	8	25.48%	4

Notes: The estimates for all countries, except Ukraine, are from Lesmond (2005), using data from 1987 to 2000. The calculations for Ukraine are for the top-30 companies ranked by liquidity, measured by the quoted spread. These 30 represent 12 per cent of the number of companies listed on the Ukrainian stock market, using data from the first half of 2006. The sample is created to make the results for Ukraine comparable to the results in Lesmond (2005). The estimates shown are equally weighted averages of the estimates for individual stocks.

Table 6. Quoted and effective bid-ask spreads for the 15 most liquid Ukrainian stocks.

	Company	Quoted bid-ask spread			Effective bid-ask spread		
		Value	St. err.	Obs.	Value	St. err.	Obs.
1	UTEL	4.88%	0.15%	470	3.16%	0.10%	800
2	UNAF	5.56%	0.26%	470	2.20%	0.10%	587
3	ZAEN	7.54%	0.25%	470	3.23%	0.17%	341
4	NITR	7.66%	0.24%	471	3.79%	0.23%	366
5	ZPST	8.33%	0.52%	365	3.66%	0.14%	550
6	MMKI	8.53%	0.31%	470	5.32%	0.23%	433
7	KSTL	8.63%	0.33%	305	3.86%	0.33%	106
8	MZVM	8.79%	0.42%	397	5.10%	0.22%	402
9	DNSS	8.82%	0.33%	284	5.37%	0.41%	128
10	STIR	9.07%	0.26%	470	5.13%	0.30%	257
11	AZST	9.19%	0.26%	470	5.01%	0.20%	456
12	DTRZ	10.40%	0.58%	313	3.89%	0.24%	301
13	CEEN	10.70%	0.37%	471	4.63%	0.24%	348
14	MSICH	11.58%	0.41%	471	5.74%	0.39%	248
15	DOEN	12.22%	0.30%	471	5.50%	0.37%	184

Notes: The average effective half-spread for each stock is multiplied by two to make it comparable to the quoted spread. The half-spread for a given trade is found from formula (4) for a sell or (5) for a buy. The estimation period is January 2005 to November 2006. Quoted spreads fell during the sample period; this explains the larger spreads in Table 6 than in Table 2, which uses data from 2006 only.

Table 7. Effective spreads by size category and market condition.

All Trade Sizes							
	Sales			Purchases			Mean effective spread
Market condition	Obs	Mean half-spread	St. Error	Obs	Mean half-spread	St. Error	
Rising	1596	2.20%	0.08%	1637	1.75%	0.04%	3.95%
Falling	1097	2.99%	0.11%	732	2.23%	0.07%	5.22%
Neutral	603	2.18%	0.10%	521	1.71%	0.06%	3.89%
Total	**3296**	**2.46%**	**0.06%**	**2890**	**1.87%**	**0.03%**	**4.33%**
Small Trades							
	Sales			Purchases			Mean effective spread
Market condition	Obs	Mean half-spread	St. Error	Obs	Mean half-spread	St. Error	
Rising	1034	2.27%	0.11%	1158	1.84%	0.05%	4.11%
Falling	783	3.18%	0.15%	513	2.23%	0.08%	5.41%
Neutral	432	2.43%	0.13%	381	1.76%	0.07%	4.19%
Total	**2249**	**2.62%**	**0.08%**	**2052**	**1.92%**	**0.04%**	**4.54%**
Medium Trades							
	Sales			Purchases			Mean effective spread
Market condition	Obs	Mean half-spread	St. Error	Obs	Mean half-spread	St. Error	
Rising	375	1.87%	0.09%	283	1.54%	0.08%	3.41%
Falling	228	2.48%	0.19%	131	1.95%	0.16%	4.43%
Neutral	101	1.93%	0.20%	87	1.40%	0.11%	3.33%
Total	**704**	**2.08%**	**0.09%**	**501**	**1.62%**	**0.07%**	**3.70%**
Large Trades							
	Sales			Purchases			Mean effective spread*
Market condition	Obs	Mean half-spread	St. Error	Obs	Mean half-spread	St. Error	
Rising	187	2.51%	0.24%	196	1.51%	0.11%	4.02%
Falling	86	2.57%	0.26%	88	2.69%	0.35%	5.26%
Neutral	70	0.97%	0.11%	53	1.90%	0.28%	2.87%
Total	**343**	**2.21%**	**0.15%**	**337**	**1.88%**	**0.12%**	**4.09%**

Notes: The sample consists of the 15 most liquid Ukrainian stocks, as in Table 6. All estimates are significant at 1 per cent significance level. Mean effective spread is the sum of the mean half spread for sales and the mean half-spread for purchases.

Table 8. Regression of quoted bid-ask spread against trading characteristics of stocks

	Specification			
	1. Eq. (8)	2. Eq. (9)	3. Eq. (9) + info index	4. Eq. (9) monthly
Return variance (σ^2)	0.5667***	0.4685**	0.3955	6.6492***
	(0.005)	(0.020)	(0.278)	(0.000)
Logarithm of price (logPrice)	-0.0232**	-0.0225*	-0.0348**	-0.0018**
	(0.047)	(0.053)	(0.021)	(0.019)
Logarithm of number of trades per day (logN)	-0.1075***	-0.1025***	-0.1206*	0.0027
	(0.003)	(0.007)	(0.089)	(0.464)
Log of daily dollar volume (LogDDV)	-0.0422			
	(0.159)			
Logarithm of market capitalization (LogMcap)	-0.0217			
	(0.322)			
Log of number of no-trading days (logNNTD)		0.0017*	0.0001	0.0027***
		(0.067)	(0.964)	(0.000)
InfoIndex			0.0012	
			(0.744)	
Intercept	1.3247	0.0666	0.2839	0.0069
	(0.012)	(0.4552)	(0.307)	(0.412)
Adjusted *R*-squared	0.451	0.455	0.419	0.423
Observations	97	97	25	275

Notes: The table presents the results of estimating eqs. (8) and (9) using OLS. For specifications 1 and 2, the sample consists of 41 stocks for 2005 and 56 stocks for 2006. For specification 3, the sample consists of 25 stocks for which an information-index score is available, with one observation for each variable during 2006. For specification 4, the sample consists of the 15 most liquid stocks, with monthly observations during January 2005 - November 2006.

Notes:

[1] Number of trades per day was found significantly different from zero only for the quoted spread regression and not for the effective spread regression.

[2] According to the FTSE Quality of Markets Criteria (Europe Frontier) assessment (FTSE 2009), PFTS receives a 'Pass' for the 'Efficient trading mechanism' criterion, and a 'Pass' for the 'Transparency – market depth information / visibility and timely trade reporting process' criterion. The assessment criteria are grouped into five blocks: (i) Market and Regulatory Environment, (ii) Custody and Settlement, (iii) Dealing Landscape, (iv) Derivatives, and (v) Size of market. For each criterion a stock market can receive one of the three grades: Pass, Restricted, or Not Met.

[3] Amihud's measure is defined in Section 4.2 below. Roll's measure estimates the bid-ask spread from the serial autocorrelation of prices. The LOT measure infers trading costs from daily returns only, including zero-return days.

[4] National Bank of Ukraine data obtained from: www.bank.gov.ua

[5] We carried out face-to-face interviews in 2008 with executives from six Ukrainian broker-dealers.

[6] We are grateful to Yuryi Ryzhkov for providing his data with the matched quotes.

[7] The Vanguard Group defines the market as falling if the stock market index declines by 20 per cent or more over at least a two-month period (or declines by 0.33 per cent, on average, per day). The Ukrainian stock market is much less active than the NYSE; if we follow the Vanguard Group rule, the majority of periods would be regarded as neutral.

[8] As explained in Section 4.1, Tables 2, 3, 4, and 5 present results based on the sample covering first half of the year 2006 and Tables 1, 6, 7 and 8 are based on the results for the period January 2005 to November 2006.

[9] Data from www.fundmarket.ua as of February 2009.

[10] The data on the number of listed companies for each market are taken from the World Bank's World Development Indicators (2006) annual publication.